BIOLOGY AND LIFE HISTORY OF THE RICE FIELD PREDATOR *ANDRALLUS SPINIDENS* F. (HEMIPTERA: PENTATOMIDAE)[1]

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ABSTRACT: The pentatomid bug, *Andrallus spinidens* (F.), is a non-specific predator on Lepidoptera larvae in rice fields of West Malaysia. Large populations of *A. spinidens* were observed associated with outbreaks of *Melanitis leda* (Satyridae). Field and laboratory studies on the biology and behavior of *A. spinidens* were conducted to clarify its role in suppressing lepidopteran populations. Development from egg to adult averaged 26 days.

During investigations of arthropod predators in rice fields of West Malaysia, the asopine pentatomid *Andrallus spinidens* (F.) was observed to be a non-specific predator on lepidopteran larvae. Further studies indicated that *Andrallus* was a potentially useful biological control agent in rice fields. Laboratory studies were conducted for the purpose of gaining information on life history, behavior, and ecology of the species. Specimens were collected from rice fields in Province Wellesley and Kedah, West Malaysia.

A review of the literature, distribution, and recorded hosts of *Andrallus spinidens* can be found in a paper by Kajendra (1971).

Methods and Materials

Studies were conducted on both field-collected and laboratory-reared specimens. For instar development studies, female pentatomids were placed in individual petri dishes for egg collection. After eggs were laid the females were separated from the eggs.

Adults and nymphs were fed grain moth larvae and larvae of various lepidopteran species collected from the rice fields. Living larvae were given to each pentatomid daily.

First instar nymphs were given damp cotton and left in the container with the eggs until they molted. After molting they were moved to individual dishes and reared to adults. Stock cultures were maintained in cages 3 x 3 feet in the laboratory in order to have specimens at various developmental stages for behavioral and ecological studies.

Lepidoptera larval weights were determined by weighing the live larvae

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immediately before introducing them to the pentatomid predator. Larvae were weighed again immediately after feeding stopped. The difference between the first weight before feeding and the second weight after feeding was assumed to be what the pentatomid removed during its feeding.

Biology

In rearing cages, eggs were laid randomly both on dead and living leaves, as well as on the sides of the cages. There appeared to be no preference for oviposition sites, but the shape of the mass varied, depending upon the substrate. Egg masses attached to the sides of the cages or laid in petri dishes were normally irregular or elongate. Eggs laid on the leaves of rice plants were laid in two rows ranging from 2 to 5 cms. long. Regardless of the shape of the mass, eggs were glued at the base to the substrate and to each other along the sides. On living plants the upper surface of the leaf more frequently contained eggs than other parts of the plant.

The number of eggs per mass ranged from 7 to 96 with an average of 50 for 20 masses. Rajendra (1971) in India found an average of 54.47 eggs per mass.

Females were observed to mate repeatedly, but this does not appear to be necessary since females kept in isolation after a single mating laid more than one batch of eggs which hatched normally. Duration of the egg stage was 7 days (Table 1). When laid, the eggs are creamy white. After being exposed to the air they become dark silver gray. It was noted that eggs laid directly on wet filter paper remained white and did not turn dark if the filter paper was kept wet. As the eggs were nearly ready to hatch they became increasingly reddish.

Nymphal development averaged 19.0 days. The last instar required the longest development period (5.4 days); the first instar was the shortest, lasting 2.6 days. The middle instars were about equal in length (Table 1).

The first instar nymphs were gregarious, tending to congregate on the eggs. Oetting (1971) indicates the young numphs of *Podisus placidus* Uhler feed on the unhatched eggs. In the case of observed egg masses of *Andrallus spinidens* nearly all the eggs hatched. Other than perhaps feeding on the eggs, no feeding was observed during the first instar, but water was taken readily from damp cotton.

Second to fifth instar nymphs were fed on a variety of lepidopteran larvae collected from the rice fields. After molting, second to fifth instar nymphs fed almost continually until a few hours before the next molt, when they would not feed again until the new cuticle had hardened. As soon as the new cuticle had hardened, nymphs became agressive predators, attacking almost any size larvae.

In a population of mixed ages, younger nymphs often would scavenge on large larvae killed by older nymphs. Sometimes all stages of nymphs were found feeding together. Frequently the younger nymphs were observed feeding on larvae abandoned by older nymphs or adults. Both hunting and feeding may take place as a group.

The gregarious behavior of the younger instars appeared to play an important part in feeding. On several occasions I observed that 1 or 2 younger instar pentatomid nymphs were unable to subdue a larvae, but with the help of the entire group they were able to attack and kill even the very large larvae. The capture of larger larvae by young nymphs was accomplished by repeated attacks of many bugs. This gregarious behavior is most strongly expressed in the first 2 instars and to a lesser degree in instar 3. Instars 4 and 5 are mostly solitary, with the solitary behavior most strongly expressed in 5th. instar nymphs which were observed to be slightly cannibalistic if starved and confined to containers. The cannibalistic behavior was not observed in the larger cages.

Andrallus spinidens was a persistent predator. When a pentatomid nymph came in contact with a larva too big to subdue immediately, it would repeatedly follow and attack. Frequency of repeated attacks depended on the demeanor of the predator and aggressiveness of the larvae in repelling the attack. On some occasions nymphs followed a large larva for nearly a day.

Oetting (1971) suggests that pentatomids use a poison to kill their prey. My observations indicate that such a substance may be utilized. The time required for a pentatomid to kill a larva varied greatly; normally 1-4 minutes were required once a successful attack had been made. Larvae which were successful in escaping early attacks from predators were, however, greatly weakened and usually were unable to resist later attacks. Larvae which were able to escape the first few attacks would show a general weakening over time, loss of coordination, and shaking.

The observed method of attack is similar to that described by Oetting (1971) for *Podisus placidus*. The prey was approached with the labium extended and the antennae vibrating rapidly. The only contact made with the prey was with the labium and stylets. Upon insertion of the stylets the prey would start to thrash about and frequently try to bite the pentatomid. Frequently the pentatomid would use the pronotum to avoid being bitten. Orienting the pronotum toward the head of the larva proved to be a successful method of defense. This method was often successfully used to protect the forelegs.

Observations of behavior indicate that the pentatomid uses some kind of mechanism of communication. The finding of a caterpillar attracted nearby pentatomid nymphs. In rearing cages many nymphs and adults repeatedly fed on a single prey and within a few minutes of an attack all pentatomids in the cage were seen feeding or rapidly moving about looking for food.

When a normally solitary fifth instar pentatomid began to feed, it rapidly attracted other nymphs. When one fifth instar nymph was placed on each of five rice plants, arranged in such a way that only one or two leaves were touching and providing a bridge for the nymphs to cross from one plant to the next, it was found that during hunting only occasional contact was made between bugs. Only one or two of the insects would be hunting at any given time while the others were inactive. The introduction of a lepidopteran larva made little difference except when it came close enough to disturb a nymph, then that predator would pursue it. Once a larva was attacked, however, all other pentatomids were affected. The other four nymphs would become active and start to hunt for the point of attack. Hunting did not appear random but directed at trying to reach the area of predation. As the hunting nymphs moved from plant to plant and got closer, their intensity of search appeared to increase. The distance the nymph was away from the killed larva appeared to have an effect on both the required time for it to respond to the kill and its persistence in reaching the prey.

When the maximum number of prey which could be consumed by fifth instar nymphs during a twelve hour day was figured based on feeding time per gram wet weight in the laboratory, it was found that many more small larvae could be consumed during the day than larger ones. Eighteen larvae weighing 0.01 grams could be consumed but only eight larvae weighing 0.05 grams. As larvae became larger than 0.09 - 1.0 grams the increase in larval weight made little difference in the number eaten per day.

Number of larvae eaten per day for each predator was unaffected by the feeding capacity of the pentatomid. Eighteen larvae with a wet weight of 0.01 grams per individual would total 0.18 grams, far below the feeding capacity of the fifth instar nymphs, some of which killed larvae weighing a total 0.40 grams wet weight and consumed 0.18 grams of body fluids in eight hours. Sixty to eighty percent of the wet weight was usually consumed.

Fifth instar nymphs were able to feed continually for several hours. The average weight for 18 fifth instar nymphs was 0.06 grams. They were observed to eat as much as 0.18 grams during eight hours of continual feeding, equal to 3.1 times their average body weight. They killed as much as 7 times their own body weight during the same time. Many were still feeding at the end of eight hours.

Role as Predator

Andrallus spinidens was abundant in rice fields only when associated with out breaks of lepidopteran larvae such as *Melanitis leda.* During periods when non-stem borer lepidopteran larvae were scarce, few specimens of *A. spinidens* were observed.

There are 3 factors which should favor *Andrallus spinidens* as a predator of rice pests: 1) relatively short life cycle, 2) aggressive feeding behavior, and 3) ability to feed continually for several hours. There are also 3 behavioral characteristics which contribute to survival of the younger instars: 1) gregarious hunting and feeding, 2) mixed-aged groups feeding together, allowing the young instars to feed on the prey of larger nymphs, and 3) the apparent attraction of nymphs to a fresh kill by other nymphs. The attraction phenomenon would be a particular advantage in low-density situations, clumped populations of prey, and localized prey increases.

The number of larvae eaten per day for an individual predator is determined by larval size and hunting time required by the predator. As the size of the larvae increases, hunting time is less important since the actual time spent feeding is so large, but with smaller larvae the number of larvae eaten will depend on the amount of time taken to find the various prey.

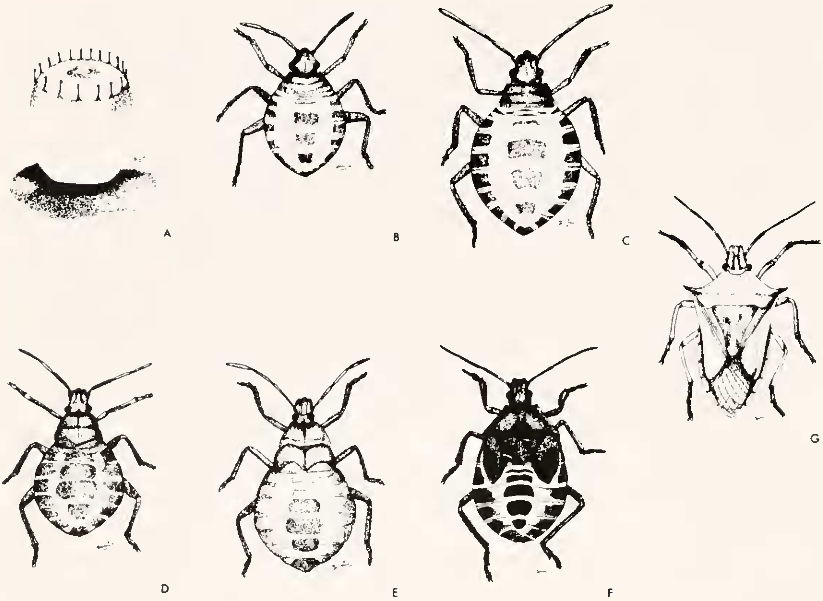
With second and, to some degree, third instar nymphs the number of larvae eaten will also depend on capture ability. When larvae are maximum size that can be overpowered, significant time may be spent in killing the larva. Laboratory observations indicated that under some circumstances capture time could amount to hours.

It is possible that the attraction phenomenon may also have some limiting effects in terms of number of larvae eaten. Under conditions where the nymphs are widely dispersed, the movement of the nymphs to one spot would reduce total hunting time and area searched. It was observed, however, that if a pentatomid nymph is moving to a prey and comes across an undetected larva in the process, it will attack the living larva and not go to the killed larva.

Observations of field populations along with laboratory studies indicate that *Andrallus spinidens* may be of limited importance under low host density. Its major usefulness is likely in connection with outbreak or moderate to high density conditions, where its short life cycle time and continuous feeding ability should operate to make it a useful control agent.

Table 1. Development (days) of eggs and nymphs of *Andrallus spinidens.*

Stage	Number	Range	Mean	Cumulative Mean age
Eggs	20	7	7	7.0
Nymphal				
First	20	2-3	2.6	9.6
Second	20	4	4	13.6
Third	20	3-4	3.4	17.0
Fourth	19	3-5	3.6	20.6
Fifth	17	4-8	5.4	26.0



Figs. A-G. *Andrallus spindens.* A, Lateral view of egg; B. first instar; C, second instar; D, third instar; E, fourth instar; F, fifth instar; G, adult.

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